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April 1984

DROP SIZE SPECTRA FOR APPLICATIONS OF THURICIDE WITH MICRONAIR AND UNIMIZER ATOMIZERS



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Forest Pest Management
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PREFACE

The work reported herein was performed by Professor W.E. Yates, Research Associate R.E. Cowden, and Professor N.B. Akesson, Department of Agricultural Engineering, University of California, Davis. The purpose of the wind tunnel test was to establish atomization characteristics of Thuricide 32LV with the Micronair 5000 spray device at air velocities of 70 and 90 mph. Additionally, the Unimizer was characterized at 100 mph. Information is provided on rpm, pressure, blade size, blade angle, and flowrate settings to achieve specific droplet spectra and application rates.

Funding was provided by USDA Forest Service, Forest Pest Management, Washington Office. Questions and comments should be directed to the Project Officer, John W. Barry, 2810 Chiles Rd., Davis, CA 95616.

Drop Size Spectra for Applications of Thuricide with Micronair and Unimizer Atomizers

W. E. Yates, R. E. Cowden and N. B. Akesson

Drop size spectra were measured with a spray containing 50% Thuricide 32 LV and 50% water and with the Micronair AU 5000 and Unimizer units in our wind tunnel at selected speeds of 70, 90 and 100 mph.

Equipment and Materials:

Fig. 1 shows the overall view of the wind tunnel and test equipment. The wind tunnel has a test section 8 ft. long with a 2 x 2 ft. cross section. A PMS OAP-2D-GA1 with a PMS 11-C data acquisition system was used to measure the drop size spectra, Fig. 2. Fig. 3 shows a closeup of the laser probe and Micronair AU 5000 atomizer in the wind tunnel. Fig. 4 shows a view of the Micronair digital flow meter and digital RPM indicator used for the tests. Fig. 5 illustrates the AU 5000 atomizer with a hydraulic motor drive. Fig. 6 shows the portable hydraulic pump used to drive the motor on the Micronair unit.

Procedures:

Table 1 lists the computed flow rates for the specified airspeeds, swath width and number of spray units for each desired test condition.

The next step involved mounting the spray unit into the center of the wind tunnel test section and measuring the spinner RPM at selected airspeeds, flow rates, blade settings and blade lengths. Please note the recommended maximum speed is 12,000 RPM and use of blade angles less than 35° could result in overspeeding when liquid flow is cut off. Thus, note the settings for the Micronair with an (*) denotes the use of the long blade (6") and a blade angle of 35° which does not overspeed when the liquid flow is shut off.

The drop size tests were conducted with the hydraulic motor drive on the

Micronair unit because tests could not be conducted with the long blades due to limited size of the wind tunnel. Thus the hydraulic motor was used to drive the AU 5000 at the speeds determined in the above tests at selected conditions.

Results:

Table 3 summarizes the drop spectra data. It is apparent that flow rate, airspeed and RPM all have an important effect on drop spectra. The two tests marked with an (*) represents tests with the 6" blade at a 35° angle. As shown the AU 5000 with the 6" blade and 35° angle produced a VMD of 110 μm at 70 MPH and a flow rate of 2.2 gpm. Also, with an increased speed up to 90 MPH and an increased flow rate up to 2.8 gpm it produced a VMD of nearly the same size, 107 μm . The Unimizer at 100 MPH, and a flow rate of 3.1 gpm produced a much lower RPM than the Micronair and consequently a larger VMD, 166 μm . Also, note the widest range of drop size was produced with the AU 5000 at the lower airspeed, 70 MPH, and lower RPM, 6400.

Fig. 7 illustrates the above data in graphical format.

The complete drop spectra results are included in Appendix A.

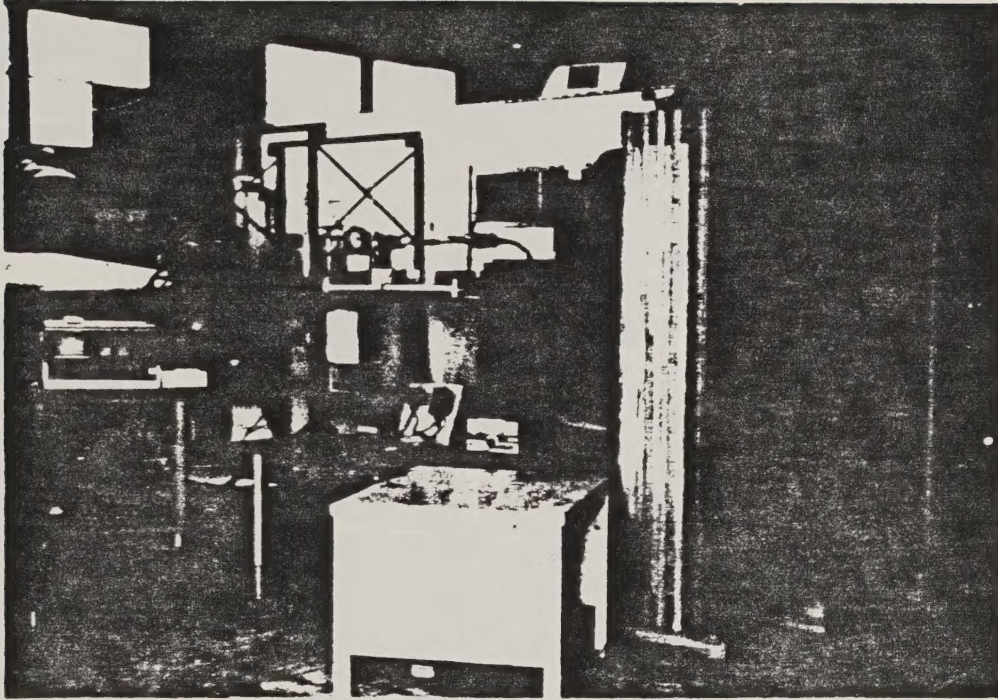


Fig. 1. Wind tunnel and test equipment.

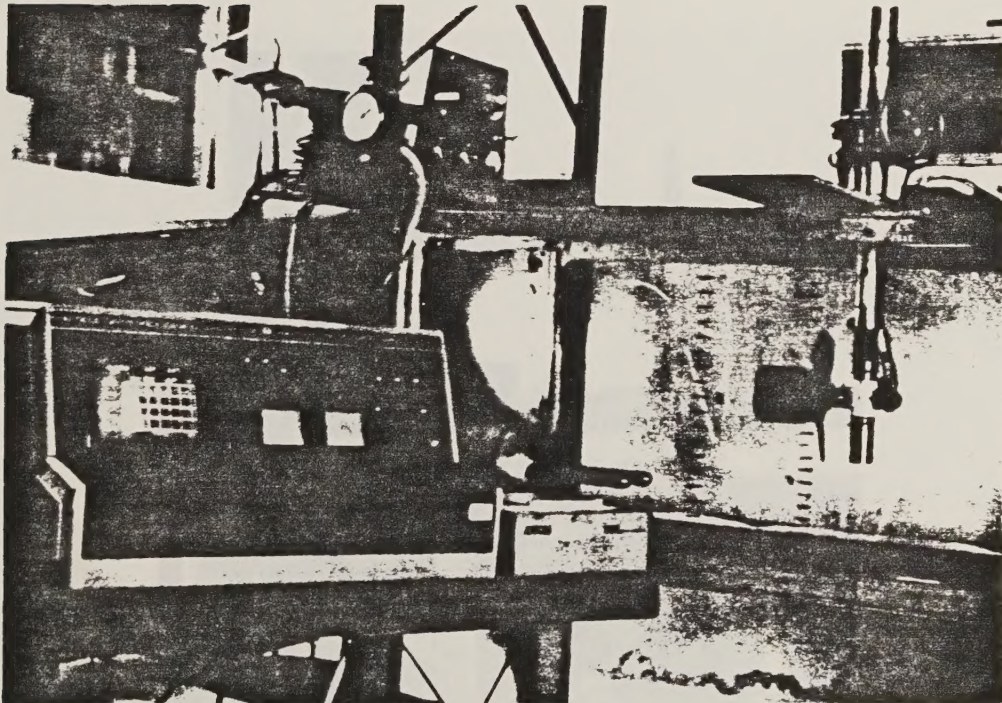


Fig. 2. Data acquisition system, wind tunnel, atomizer and probe in place.

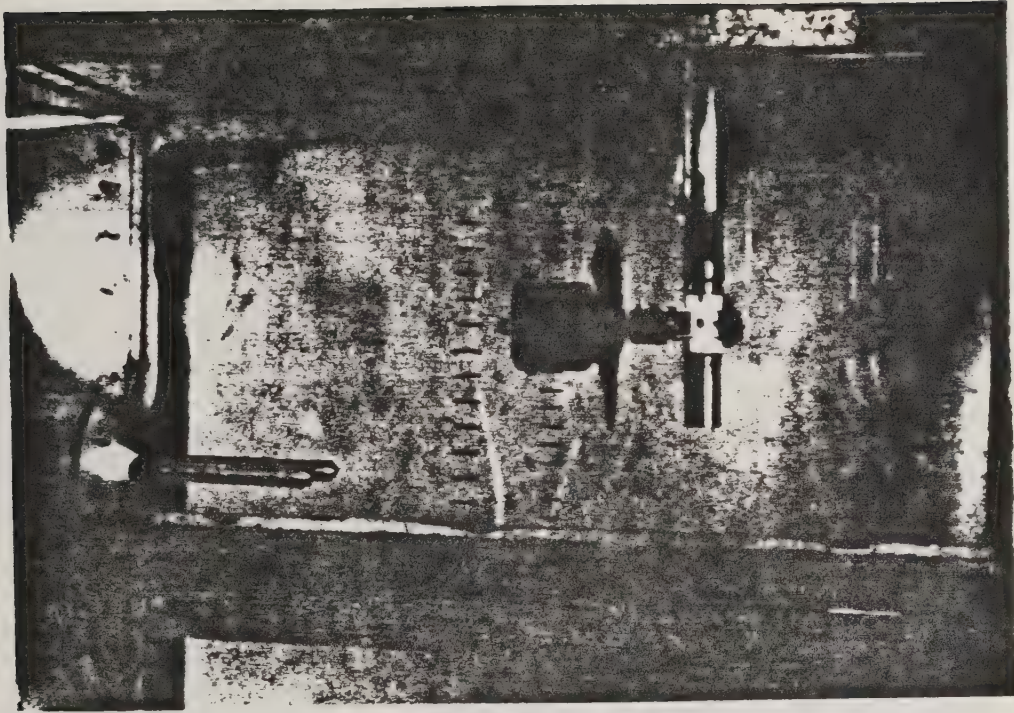


Fig. 3. Laser probe and Micronair AU 5000 in wind tunnel.



Fig. 4. Digital flow meter, digital RPM indicator and pressure gage.

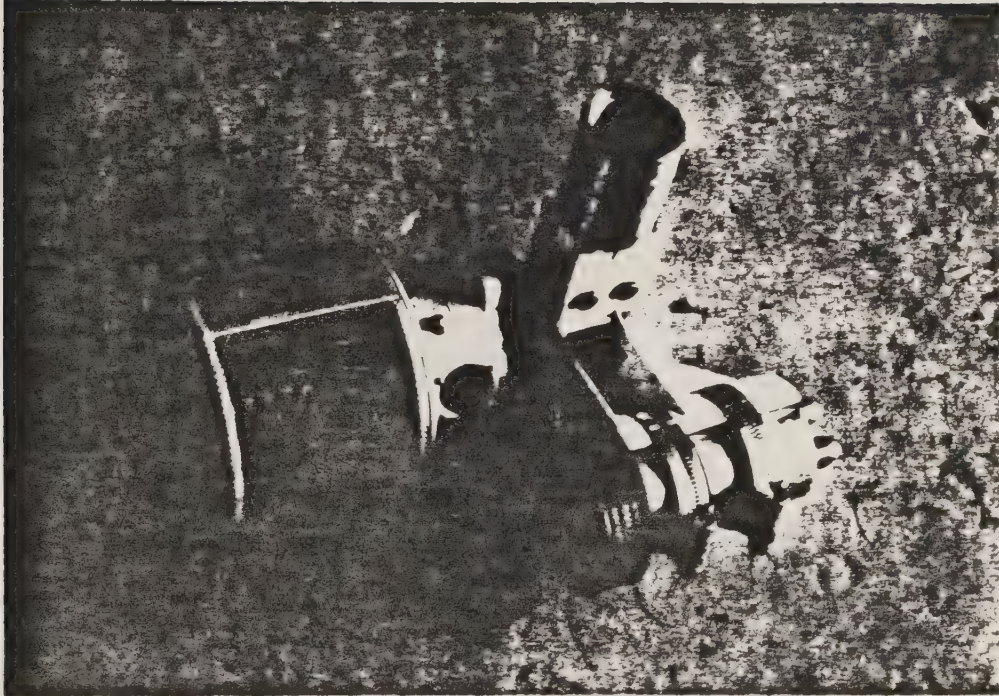


Fig. 5. Hydraulic motor drive on Micronair AU 5000 atomizer.

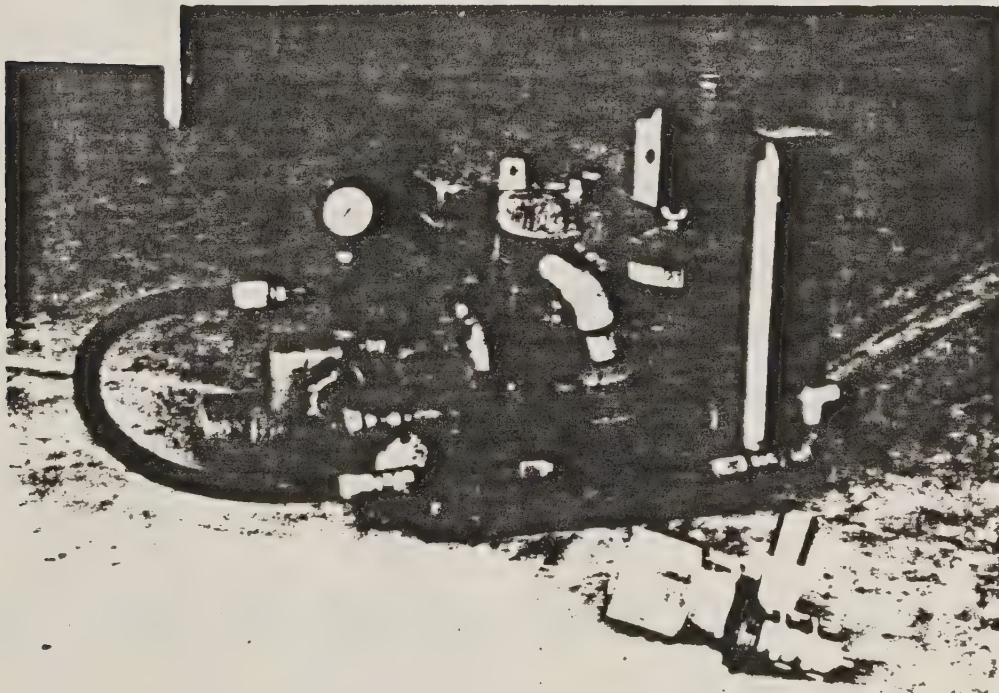


Fig. 6. Portable hydraulic pump used to drive atomizer motor.

Table 1

Flow Rates Required for Selected Applications
All applications based on 96 oz/acre

Airspeed MPH	Swath Width Feet	Total Flowrate GPM	No. of Spinners No.	Flow Rate per Spinner GPM
50	125	9.47	4	2.37
70	125	13.26	6	2.21
90	125	17.05	6	2.84
100	125	18.94	6	3.16

Table 2

Rotational Speed at Selected Airspeeds and Flowrates

Spinner Type	Airspeed MPH	Flow Rate GPM	Spinner RPM	Blade Length in.	Blade Setting
AU 5000	50	2.4	4160	5.	35°
AU 5000	50	2.4	4880	6.	35°
AU 5000	70	2.2	6420	3.63	35°
AU 5000	70	2.2	1,340	5.	25°
AU 5000	70	2.2	6950	5.	25°
AU 5000	70	2.2	5200	5.	40°
*AU 5000	70	2.2	7550	6.	35°
AU 5000	70	2.2	5330	6.	40°
AU 5000	90	2.8	8170	3.63	35°
AU 5000	90	2.8	8650	5.	35°
AU 5000	90	2.8	6800	5.	40°
*AU 5000	90	2.8	8900	6.	35°
	90	2.8	6760	6.	40°
Unimixer	100	3.2	5900	--	No. 6

Table 3

Drop Size at Selected Spinner Speeds and Flow Rates
 AU 5000 tests with hydraulic motor drive
 All tests with 50% Thuricide 32 LV, 50% water

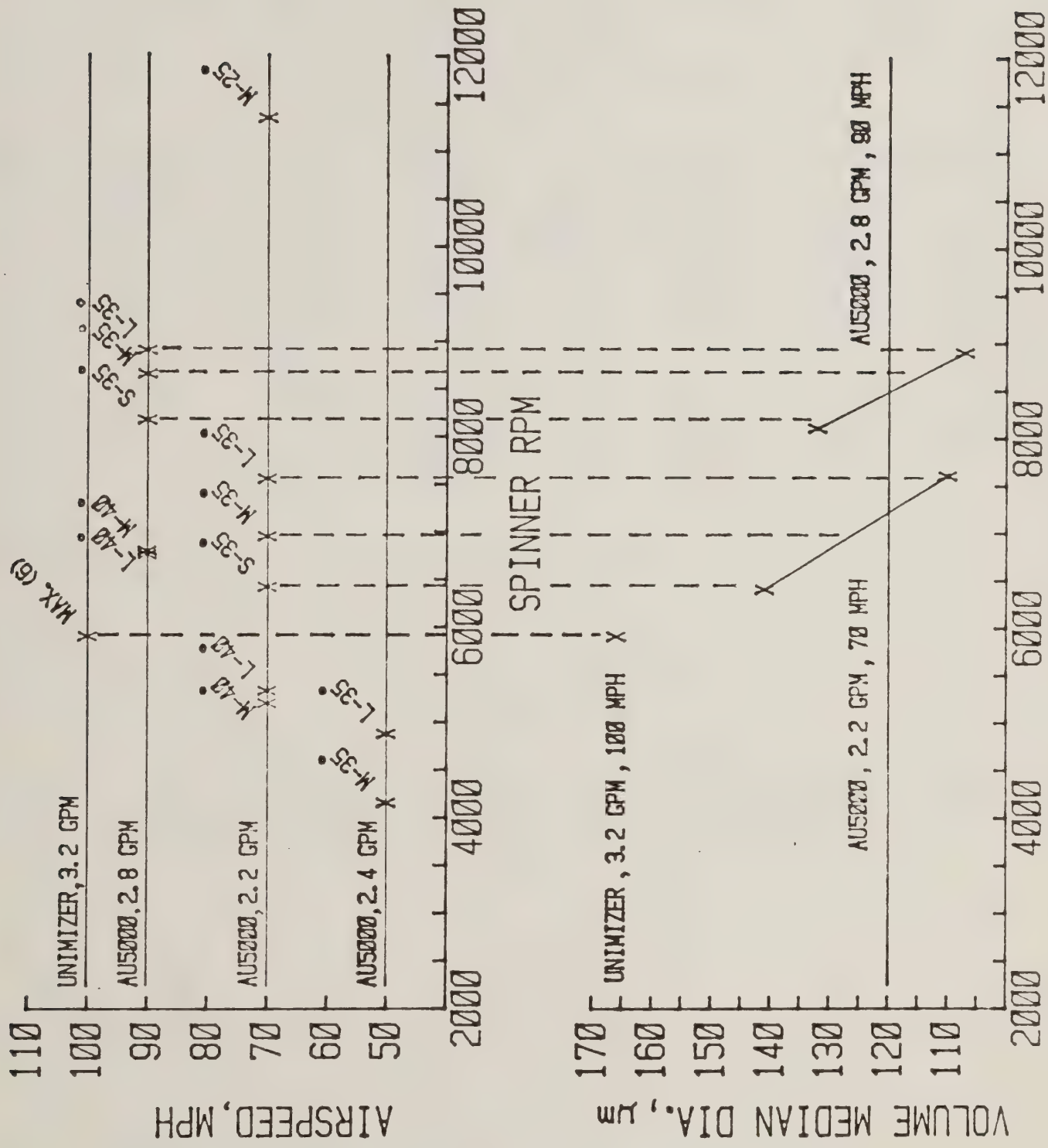
Spinner Type	Airspeed MPH	Flowrate GPM	RPM	D _{V.1} μm	D _{V.5} μm	D _{V.9} μm	R.S. μm
AU 5000	70	2.2	6400	70	141	272	1.43
*AU 5000	70	2.2	7600	60	110	164	0.95
AU 5000	90	2.8	8100	65	132	238	1.31
*AU 5000	90	2.8	8900	58	107	155	0.91
Unimixer	100	3.1	5900	91	166	246	0.93

*Test conditions that produced a volume median diameter < 120 μm.

Table 4

Adjustments Required for Selected Flow Rates
 with 50% Thuricide, 50% Water

<u>Atomizer</u>	<u>Setting</u>	<u>Pressure</u>	<u>Flow Rate</u>
AU 5000	VRU #13	17 psi	2.2 gpm
AU 5000	VRU #13	22 psi	2.8 gpm
Unimixer	#24	15 psi	3.2 gpm



AU5000
 BLADE-ANGLE
 S-3.63"
 M-5.0"
 L-6.0"

Fig. 7

Appendix A

10.1.30

AU5000,7600 RPM,70 MPH,2.2 GPM,THURICIDE

DTG 84/04/11 10:17:42

DFM=1.0--2.0 MHz

UPPER LIMIT.	N(RAW)	N/SEC	gm/SEC	% N	% VOL.	ACCUMULATED	
						% N	% VOL.
56	3660	1.61E 08	5.31	55.20	7.62	55.20	7.62
89	4747	7.87E 07	15.65	26.93	22.47	82.13	30.09
122	5843	3.63E 07	22.03	12.41	31.63	94.53	61.72
154	5659	1.32E 07	18.06	4.52	25.93	99.05	87.65
187	3596	2.25E 06	5.82	0.77	8.36	99.82	96.01
219	1785	361437	1.58	0.12	2.27	99.94	98.28
252	650	159383	1.09	0.05	1.56	100.00	99.84
284	125	9549	0.10	0.00	0.14	100.00	99.98
318	13	978	0.01	0.00	0.02	100.00	100.00
351	0	0	0.00	0.00	0.00	100.00	100.00
TOTALS		2.92E 08	69.65				

TOTAL RAW PARTICLES.... 26078/33467-- 77.92%

NUMBER MEAN DIAMETER... 62.42 MICROMETERS S.D.... 30.41

VOLUME MEAN DIAMETER... 76.94 MICROMETERS S.D.... 94.04

SAUTER MEAN DIAMETER... 94.48 MICROMETERS

DN0.1... 0.00 MICROMETERS DV0.1... 59.76 MICROMETERS

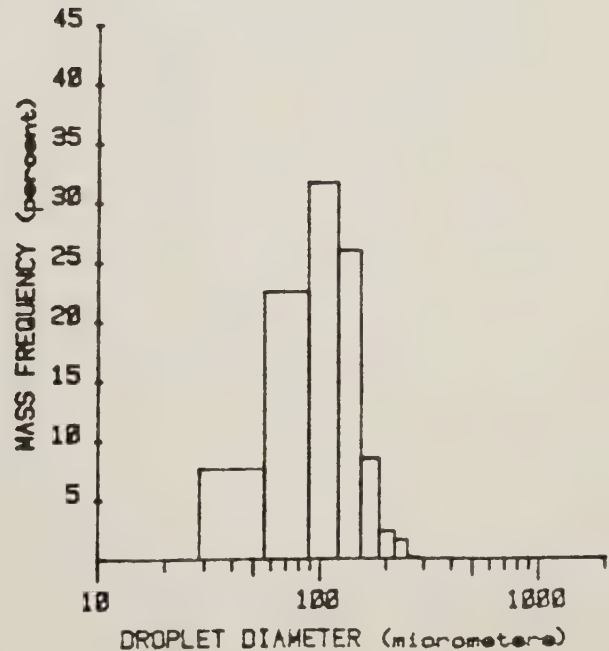
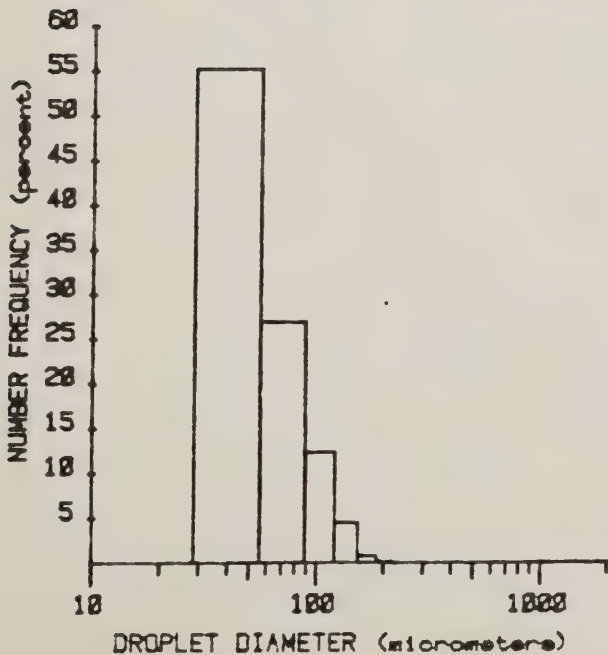
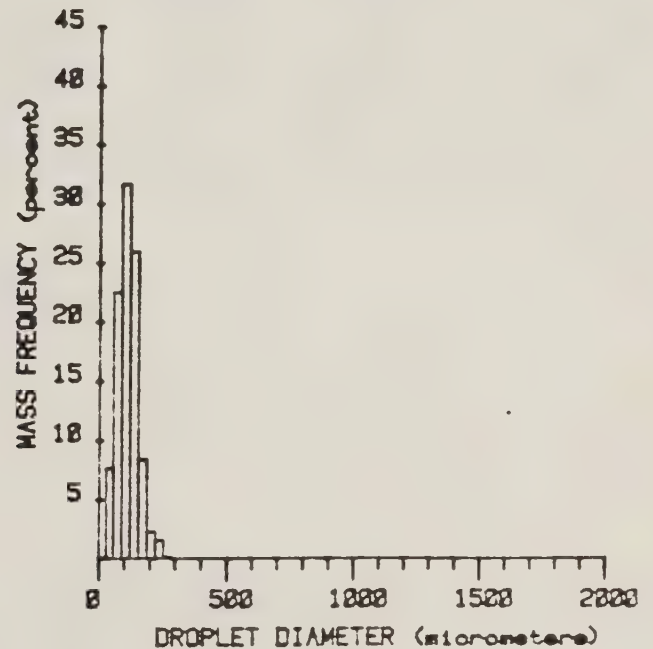
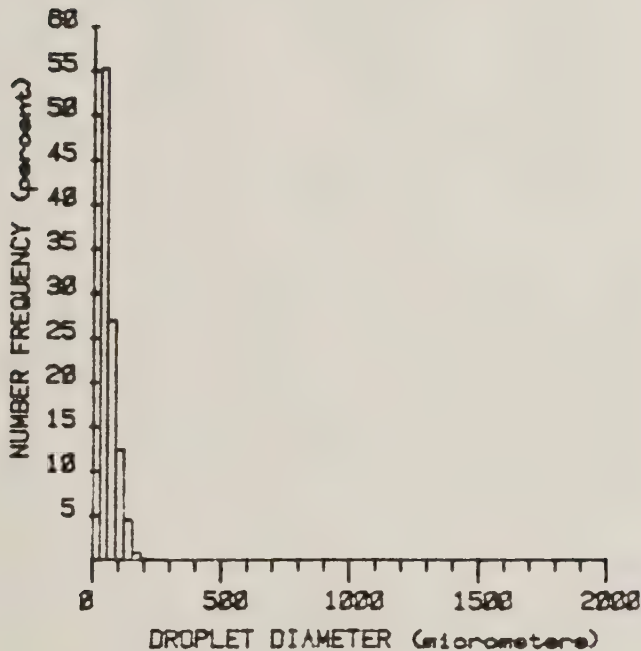
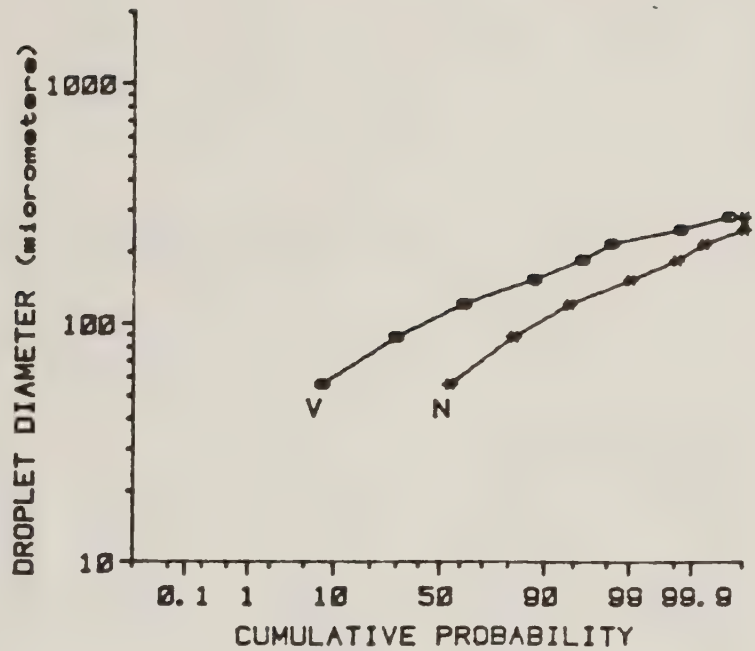
DN0.5... 0.00 MICROMETERS DV0.5... 109.70 MICROMETERS

R.S.... 0.95

DN0.9... 109.88 MICROMETERS DV0.9... 163.54 MICROMETERS

Nozzle Type..... AU5000
 Nozzle Angle Rel.
 to Airstream..... 0°
 Spray Pressure..... 17 PSI
 Airspeed..... 70 MPH

Distance to Probe... 25 cm.
 Depth of Field..... 1.0 cm.
 Slice Rate..... 2.0 MHz
 Date..... 84/04/11
 Time..... 10:17:42
 File Number..... 10.1.30



10.1.31

AU5000,8900 RPM,90 MPH,2.8 GPM,THURICIDE

DTG 84/04/11 10:40:31

DFM=1.0--3.0 MHz

UPPER LIMIT	N(RAW)	N/SEC	gm/SEC	% N	% VOL.	ACCUMULATED	
						% N	% VOL.
56	2616	2.08E 08	6.86	56.83	8.47	56.83	8.47
89	3753	9.67E 07	19.22	26.36	23.75	83.19	32.22
122	4354	4.44E 07	26.98	12.11	33.34	95.30	65.56
154	4266	1.43E 07	19.60	3.91	24.21	99.21	89.77
187	2579	2.58E 06	6.68	0.70	8.25	99.91	98.02
219	947	274564	1.20	0.07	1.48	99.98	99.50
252	250	54087	0.37	0.01	0.46	100.00	99.96
284	22	2173	0.02	0.00	0.03	100.00	99.99
318	6	720	0.01	0.00	0.01	100.00	100.00
351	0	0	0.00	0.00	0.00	100.00	100.00
TOTALS		3.67E 08	80.93				

TOTAL RAW PARTICLES.... 18793/25208-- 74.55%

NUMBER MEAN DIAMETER... 61.19 MICROMETERS S.D.... 29.34

VOLUME MEAN DIAMETER... 75.00 MICROMETERS S.D.... 90.41

SAUTER MEAN DIAMETER... 91.61 MICROMETERS

DN0.1... 0.00 MICROMETERS DV0.1... 58.39 MICROMETERS

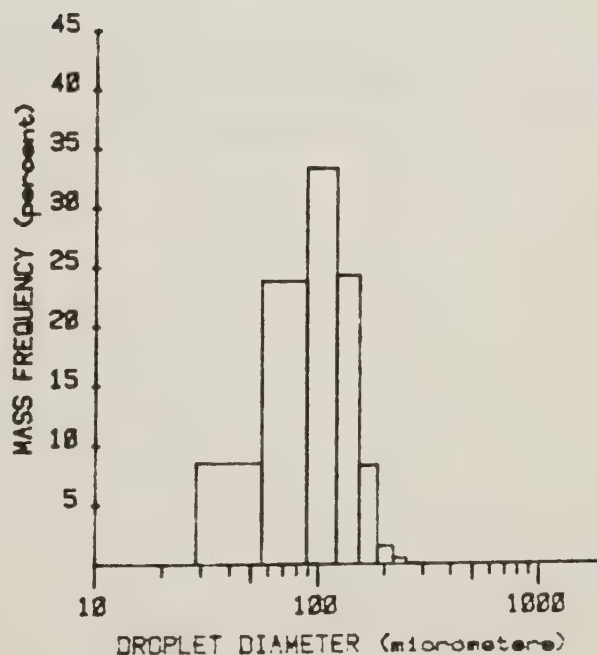
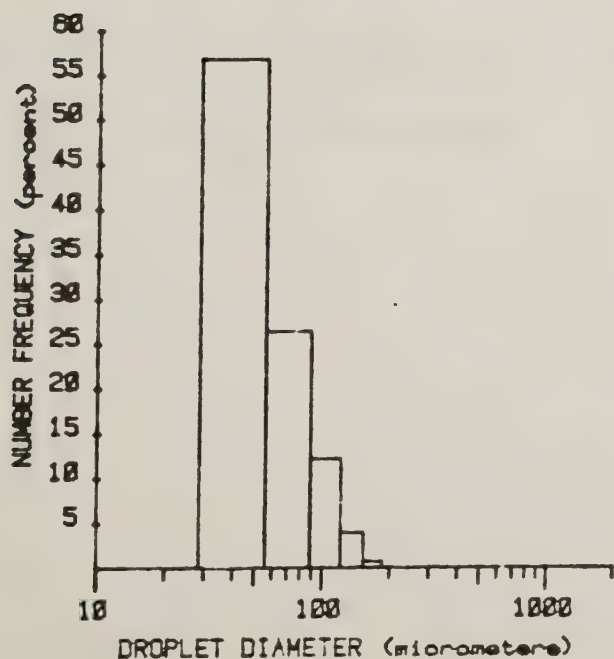
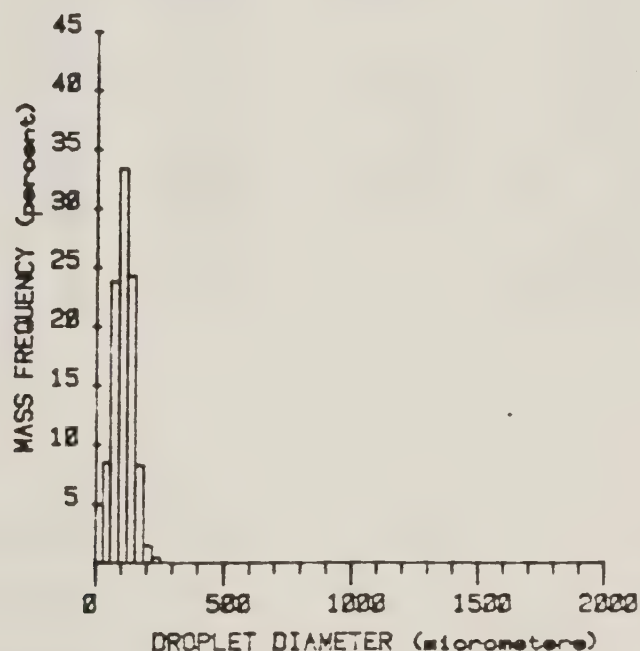
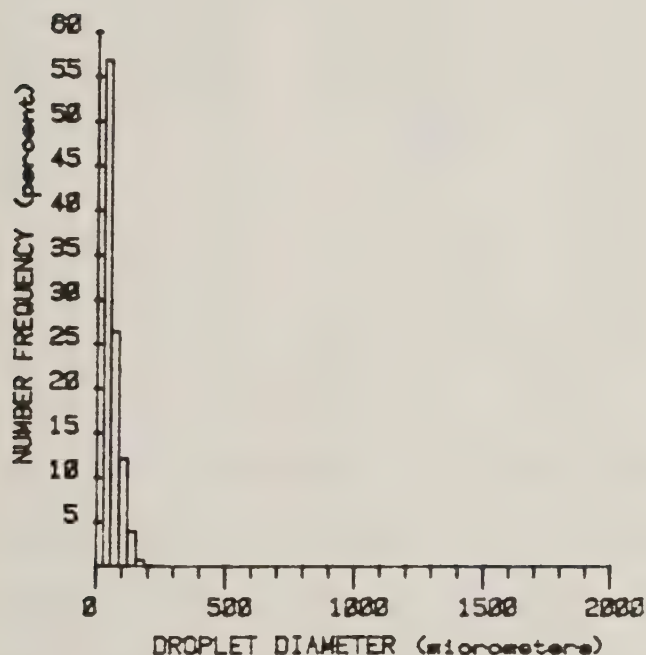
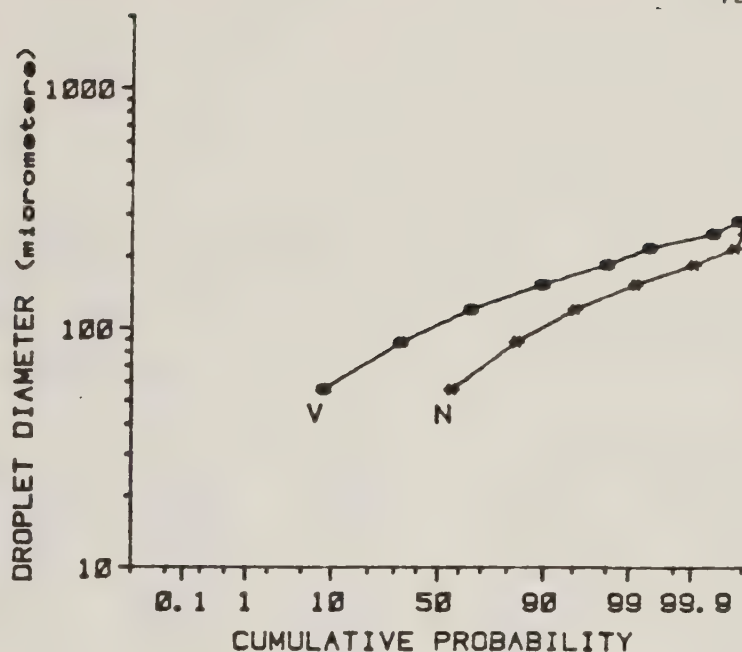
DN0.5... 0.00 MICROMETERS DV0.5... 106.53 MICROMETERS

R.S.... 0.91

DN0.9... 107.49 MICROMETERS DV0.9... 155.18 MICROMETERS

Nozzle Type..... AU5000
 Nozzle Angle Rel.
 to Airstream..... 0°
 Spray Pressure..... 22 PSI
 Airspeed..... 90 MPH

Distance to Probe... 25 cm
 Depth of Field..... 1.0 cm
 Slice Rate..... 3.0 MHz
 Date..... 84/04/11
 Time..... 10:40:31
 File Number..... 10.1.31



AU5000,6400 RPM,70 MPH,2.2 GPM,THURICIDE

DTG 84/04/11 14:25:10

DFM=1.0--2.0 MHz

UPPER LIMIT	N(RAW)	N/SEC	gm/SEC	% N	% VOL.	ACCUMULATED % N	ACCUMULATED % VOL.
56	3564	2.10E 08	6.89	62.35	5.84	62.35	5.84
89	3866	5.81E 07	11.56	17.30	9.80	79.64	15.64
122	4089	3.87E 07	23.51	11.51	19.93	91.16	35.57
154	4926	2.09E 07	28.53	6.20	24.19	97.36	59.76
187	3500	4.90E 06	12.68	1.46	10.75	98.82	70.51
219	2112	759925	3.32	0.23	2.82	99.05	73.32
252	980	237983	1.62	0.07	1.37	99.12	74.70
284	240	2.96E 06	29.76	0.88	25.23	100.00	99.93
318	51	4631	0.07	0.00	0.06	100.00	99.98
351	11	786	0.02	0.00	0.01	100.00	100.00
382	1	53	0.00	0.00	0.00	100.00	100.00
414	0	0	0.00	0.00	0.00	100.00	100.00
447	0	0	0.00	0.00	0.00	100.00	100.00
479	1	57	0.00	0.00	0.00	100.00	100.00
512	0	0	0.00	0.00	0.00	100.00	100.00
TOTALS		3.36E 08	117.95				

TOTAL RAW PARTICLES..... 23341/28947-- 80.63%

NUMBER MEAN DIAMETER... 63.45 MICROMETERS S.D..... 38.82

VOLUME MEAN DIAMETER... 87.54 MICROMETERS S.D..... 126.30

SAUTER MEAN DIAMETER... 121.27 MICROMETERS

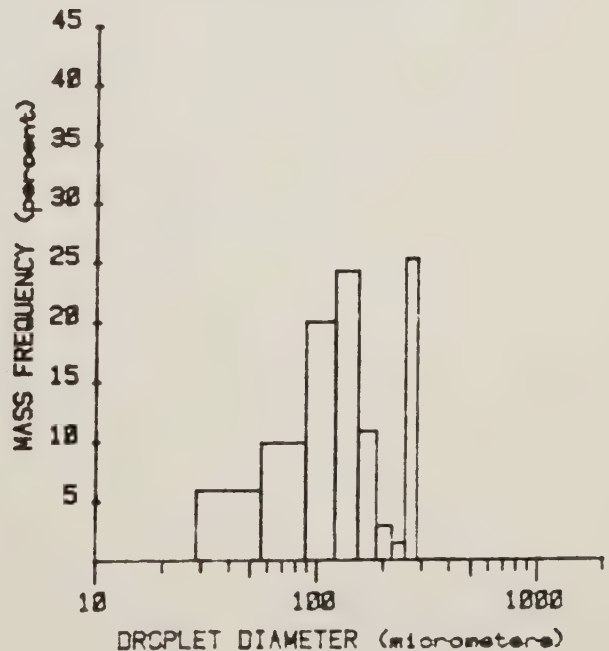
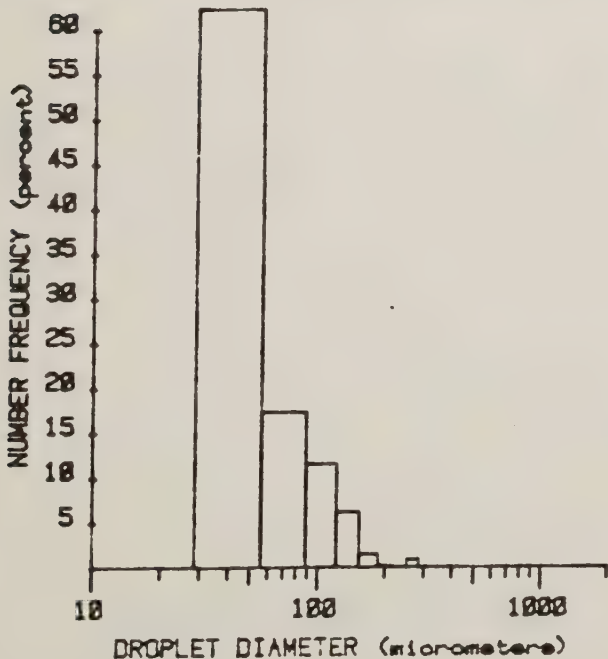
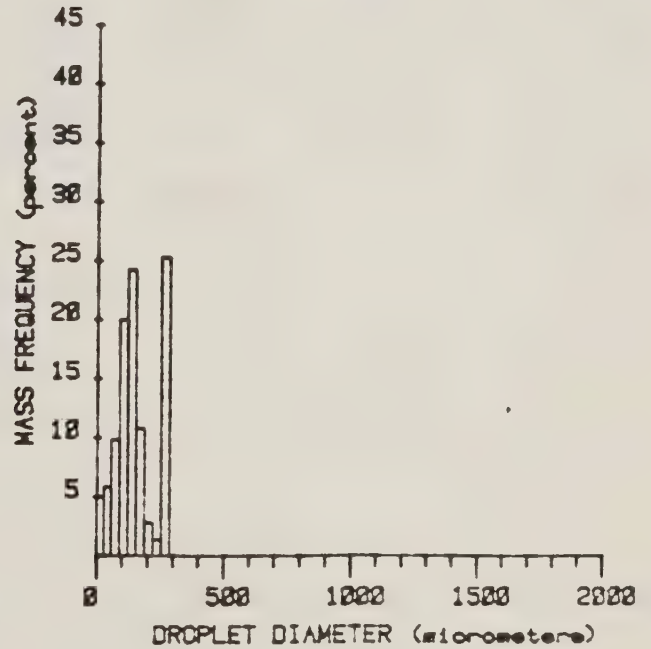
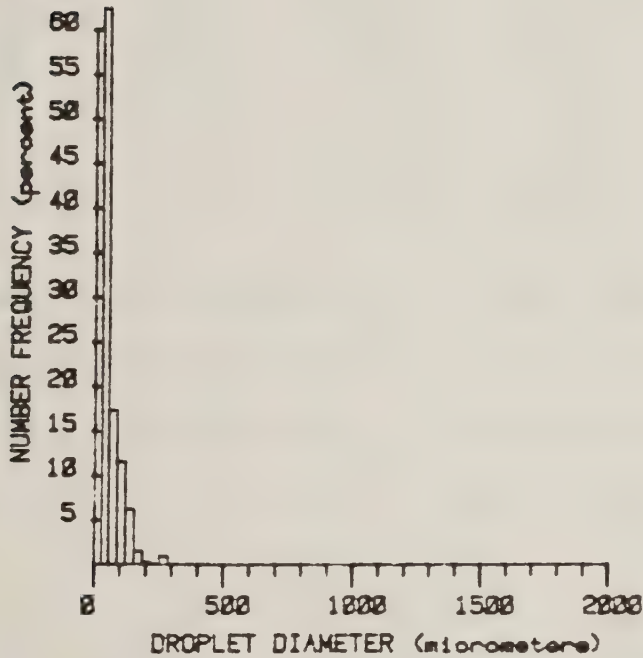
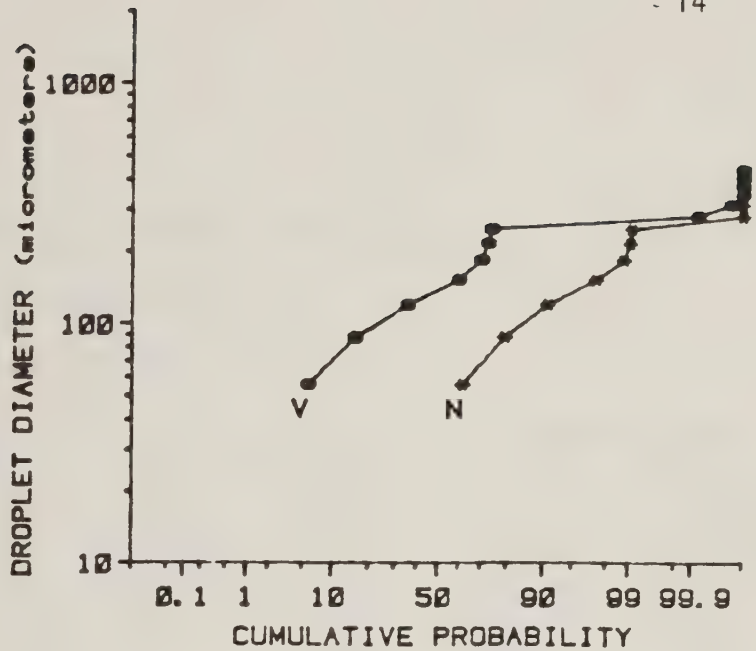
D_N0.1... 0.00 MICROMETERS D_V0.1... 70.26 MICROMETERSD_N0.5... 0.00 MICROMETERS D_V0.5... 141.29 MICROMETERS

R.S..... 1.43

D_N0.9... 118.61 MICROMETERS D_V0.9... 271.81 MICROMETERS

Nozzle Type..... AU5000
 Nozzle Angle Rel.
 to Airstream..... 0°
 Spray Pressure..... 17 PSI
 Airspeed..... 70 MPH

Distance to Probe... 25 cm
 Depth of Field..... 1.0 cm
 Slice Rate..... 2.0 MHz
 Date..... 84/04/11
 Time..... 14:25:10
 File Number..... 10.1.32



AU5000,8100 RPM,90 MPH,2.8 GPM,THURICIDE

DTG 84/04/11 14:59:46

DFM=1.0--3.0 MHz

UPPER LIMIT	N(RAW)	N/SEC	gm/SEC	% N	% VOL.	ACCUMULATED	
						% N	% VOL.
56	1457	2.45E 08	8.06	59.66	6.36	59.66	6.36
89	1818	8.77E 07	17.42	21.34	13.74	81.00	20.10
122	2142	4.65E 07	28.25	11.33	22.29	92.33	42.39
154	2047	2.27E 07	31.02	5.52	24.47	97.85	66.86
187	1299	3.91E 06	10.13	0.95	7.99	98.81	74.86
219	742	655014	2.86	0.16	2.26	98.97	77.12
252	272	4.23E 06	28.83	1.03	22.74	100.00	99.86
284	53	14955	0.15	0.00	0.12	100.00	99.98
318	11	2058	0.03	0.00	0.02	100.00	100.00
351	0	0	0.00	0.00	0.00	100.00	100.00
TOTALS		4.11E 08	126.76				

TOTAL RAW PARTICLES.... 9841/14707-- 66.91%

NUMBER MEAN DIAMETER... 63.08 MICROMETERS S.D.... 36.05

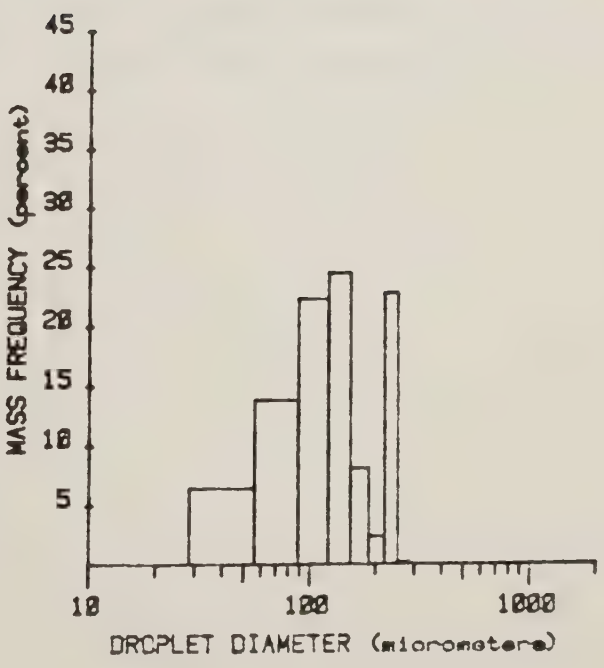
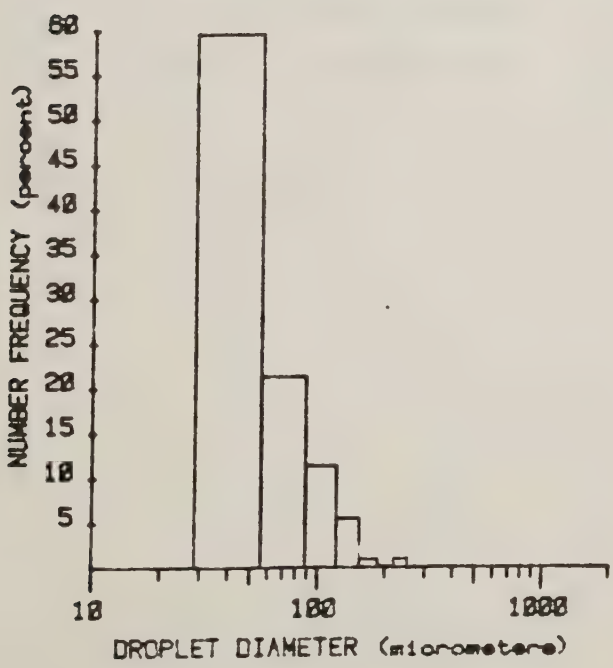
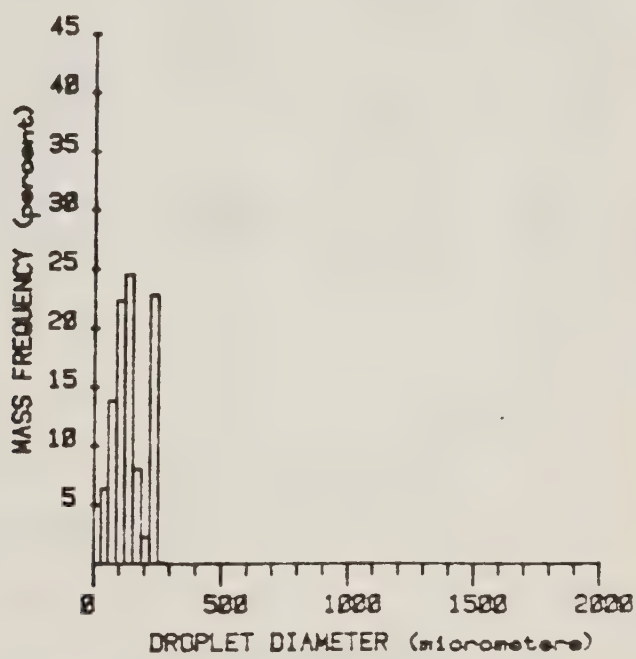
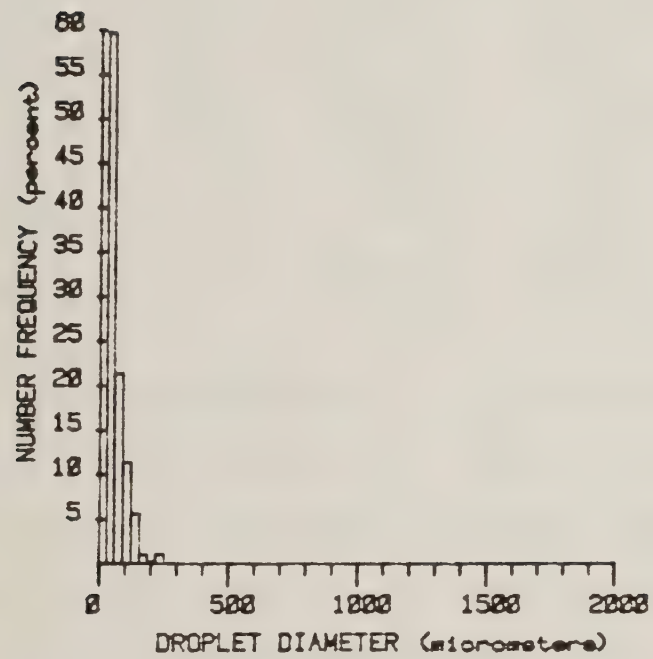
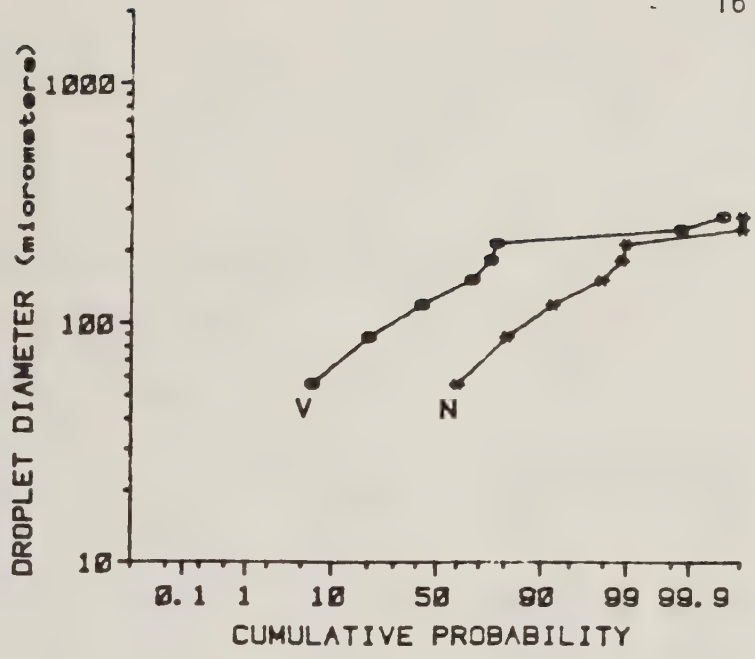
VOLUME MEAN DIAMETER... 83.88 MICROMETERS S.D.... 115.10

SAUTER MEAN DIAMETER... 111.79 MICROMETERS

D_{N0.1}... 0.00 MICROMETERS D_{V0.1}... 65.01 MICROMETERSD_{N0.5}... 0.00 MICROMETERS D_{V0.5}... 131.87 MICROMETERS R.S.... 1.31D_{N0.9}... 115.14 MICROMETERS D_{V0.9}... 238.15 MICROMETERS

Nozzle Type..... AU5000
 Nozzle Angle Rel.
 to Airstream..... 0°
 Spray Pressure..... 22 PSI
 Airspeed..... 90 MPH

Distance to Probe... 25 cm
 Depth of Field..... 1.0 cm
 Slice Rate..... 3.0 MHz
 Date..... 84/04/11
 Time..... 14:59:46
 File Number..... 10.1.33



UNIMIZER,5900 RPM,100 MPH,3.1 GPM,THURICIDE

DTG 84/04/11 15:57:08

DFM=1.0--3.0 MHz

UPPER LIMIT	N(RAW)	N/SEC	gm/SEC	% N	% VOL.	ACCUMULATED	
						% N	% VOL.
56	1247	1.28E 08	4.22	54.71	3.18	54.71	3.18
89	2844	3.86E 07	7.66	16.44	5.78	71.16	8.96
122	2807	2.93E 07	17.80	12.50	13.42	83.65	22.39
154	2905	1.95E 07	26.61	8.30	20.07	91.95	42.46
187	2115	1.04E 07	27.05	4.45	20.40	96.41	62.87
219	1302	5.15E 06	22.53	2.20	17.00	98.60	79.86
252	545	2.43E 06	16.52	1.03	12.46	99.64	92.33
284	157	651146	6.54	0.28	4.93	99.91	97.26
318	50	116966	1.68	0.05	1.27	99.96	98.53
351	17	29570	0.58	0.01	0.44	99.98	98.96
382	3	53812	1.37	0.02	1.04	100.00	100.00
414	0	0	0.00	0.00	0.00	100.00	100.00
TOTALS		2.34E 08	132.57				

TOTAL RAW PARTICLES..... 13992/18530-- 75.51%

NUMBER MEAN DIAMETER... 73.74 MICROMETERS S.D..... 48.03

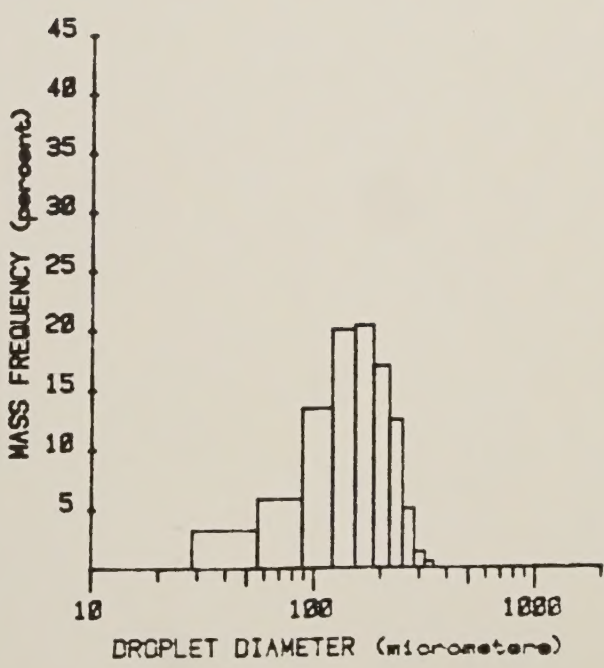
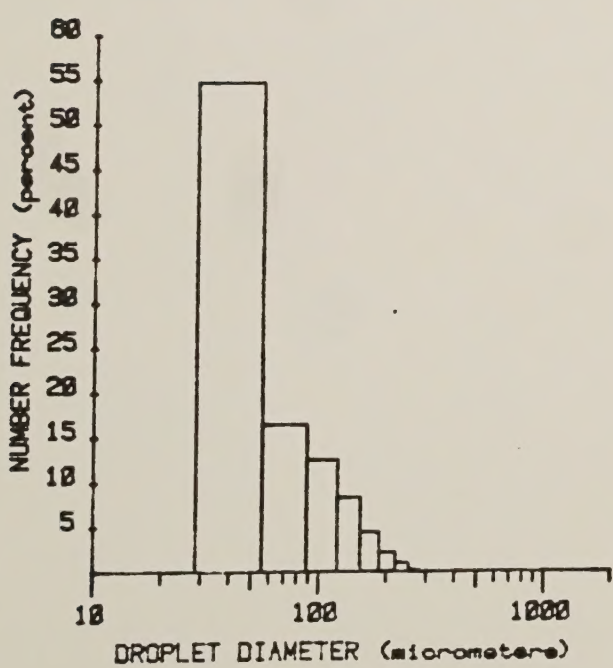
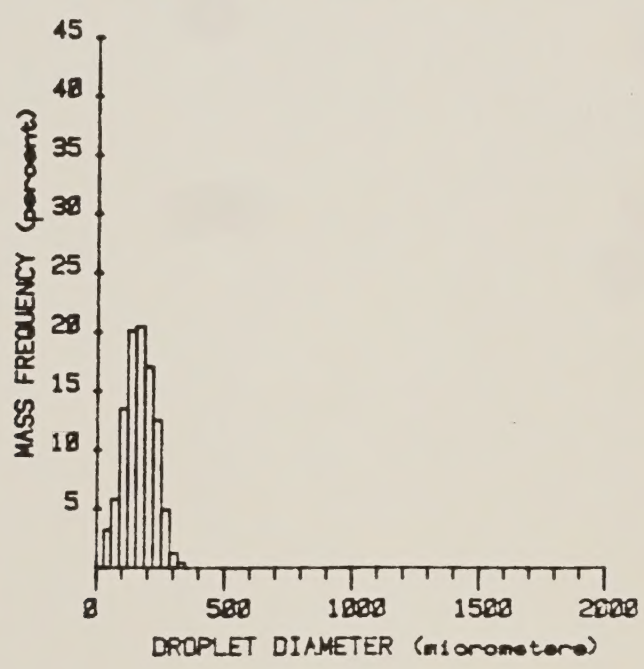
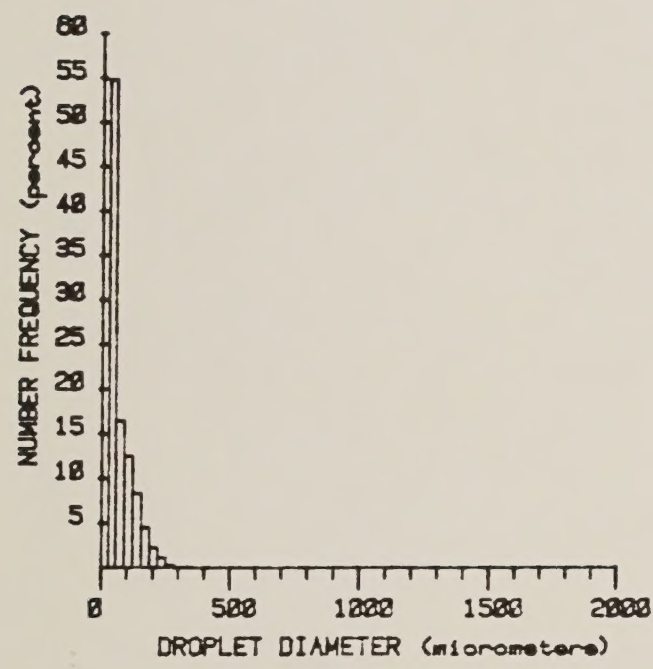
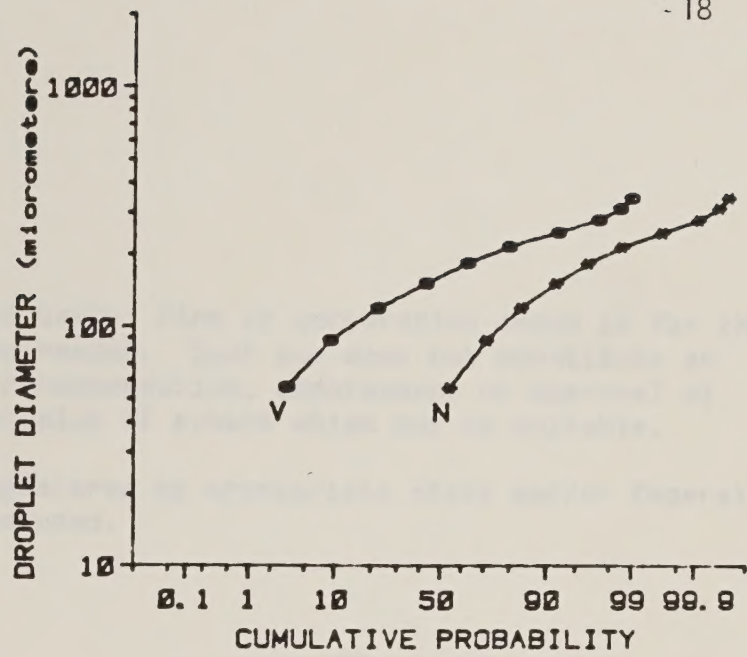
VOLUME MEAN DIAMETER... 102.63 MICROMETERS S.D..... 135.17

SAUTER MEAN DIAMETER... 139.57 MICROMETERS

D_{N0.1}... 0.00 MICROMETERS D_{V0.1}... 91.48 MICROMETERSD_{N0.5}... 0.00 MICROMETERS D_{V0.5}... 166.47 MICROMETERS R.S..... 0.93D_{N0.9}... 146.85 MICROMETERS D_{V0.9}... 246.29 MICROMETERS

Nozzle Type..... UNIMIZER
 Nozzle Angle Rel.
 to Airstream..... 0°
 Spray Pressure..... 16 PSI
 Airspeed..... 100 MPH

Distance to Probe... 25 cm.
 Depth of Field..... 1.0 cm.
 Slice Rate..... 3.0 MHz
 Date..... 84/04/11
 Time..... 15:57:08
 File Number..... 10.1.34



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